21 June 1967

Dear Dr.

Enclosed is your final draft of the paper

which is to be submitted for publication in the journal Psychophysiology.

The article as edited has been formally cleared for publication in open literature with the proviso that no Agency affiliation will be revealed.

Yours truly,

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Copy of Proposal

OPERANT REINFORCEMENT OF A MEDIATED AUTONOMIC RESPONSE

Background:

Mowrer and some other psychologists have argued that there are two distinct methods of conditioning or learning (roughly, classical conditioning and instrumental learning). Furthermore they have insisted that instrumental learning cannot be reduced to classical conditioning, and that classical conditioning cannot be explained by the laws of instrumental learning. As evidence, Mowrer points to the fact that autonomic responses and skeletal responses are qualitatively different as they are given in nature. "Here we are assuming that behavioral responses are categorically different from emotional responses: the former are 'voluntary' and subject to influence through reward and punishment (and not conditionable, strictly speaking), whereas the latter are involuntary and conditionable and not subject to control through reward and punishment, or at least not in the same way as are the overt behavioral responses." (Mowrer, 1960.)

There are everyday instances of apparent learning of an autonomic response through reward; Skinner cites the child who cried "real tears" because tears had been followed by attention and candy in the past, and recently some experimental evidence has shown that autonomic responses can be directly modified by response contingent reinforcement. However, it is not possible to rule out the effect of skeletal mediating responses in any of these cases. If the autonomic response in question is elicited by an unobserved skeletal response, it

is possible that all of the evidence for apparent autonomic learning merely reflects the parasitic reinforcement of the underlying skeletal response.

Some authors (Kendler, 1962) have insisted that even the possibility of skeletal mediators is sufficient to reject the hypothesis of autonomic learning through direct reinforcement.

The mediation explanation asserts that the mediator is a skeletal response which precedes and elicits the autonomic response. As a result of rewarding the autonomic response, the skeletal response is parasitically reinforced and learned. Thus it is implied that a typical negatively accelerated learning curve would develop for the skeletal response. It is also implied that the variability in the autonomic response can be fully explained by the changes in the frequency of the underlying skeletal response.

In the present experiment, it is proposed to set up an explicit mediating skeletal response which elicits a drop in galvanic skin resistance, and then reinforce the elicited autonomic response.

If the mediation explanation is correct, it should be possible to discover both the negatively accelerated curve of the skeletal response and to explain the variability of the elicited autonomic response. It may also be possible to compare these findings with the results of the earlier studies where an autonomic response was apparently directly reinforced. If the learning curves are very similar, it would suggest that an unknown skeletal mediator was responsible for the changes observed in the earlier work.

It is possible that results from this study will give us some kind of model of operant learning of autonomic responses as it occurs in stressful situations.

Method:

The method will be a fairly direct extension of methodology used in earlier studies /College age female volunteers will be used; this will permit a reasonable comparison with the old data. Ten experimental and 10 control subjects will be run, they will be matched for frequency of GSR nonspecific deflections on the first day of the experiment and yoked for schedules of reinforcement for the remainder of the experiment.

In the earlier studies it was observed that very large respirations occurred intermittently in what was otherwise a very regular respiration rate. These large respirations were often followed by a GSR deflection. For example, on the last day of the 1963 experiment, the eighteen subjects emitted 0 to 26 gross irregularities of respirations during the twenty minute session with an average of 7 per subject. These respirations often elicited GSR deflections. The rate of GSR elicitation varied from 12% for one of the subjects to 100% for four of the subjects; the median was 56%. In that experiment a special effort was made to avoid reinforcing respiration-elicited GSR deflections. In the present study, it is proposed that these gross irregularities of respiration be utilized as skeletal mediators; and that their associated GSR deflections be systematically reinforced. This response has the advantage of being relatively

subtle and not immediately discernible to the subject.

It is suggested that the responses be monitored by the experimenter at this point. It would probably be too complicated to set up an automatic reinforcer for what should be a relatively short, contained study.

Otherwise, methodology will follow the earlier studies. All subjects will be given 2 days of adaptation, five days of reinforcement (contingent or yoked) and three days of extinction. We will follow the policy of having the subjects sit quietly for twenty-five minutes before each day's session of twenty minutes. All girls will be screened for medical problems and run in between menstrual periods. The experiment should be conducted in a sound-proof constant temperature room.

Equipment:

Sanborn GSR with Wenger electrodes, plethysmograph (Kenelco Corp.) pneumomometer.

Data Analysis:

Do you think we can get direct taping of the output of all three variables? In GSR, all we need is a frequency count--amplitude of the deflections does not seem to be important. That should simplify the problem, too. However, minute by minute basal resistance counts should be obtained. The fact that basal resistance shifts over the twenty minute period may present special difficulties. On the plethysmograph

record, I'd like to take off heart rate (in twenty second intervals) and amplitude (about once every twenty seconds). The respiration record may be the most difficult to automate, if our experience in recording by hand is any indicator. I have ample samples of all these, plus a fairly specific outline of how they were counted by hand.

Once the data are in digital form, we will need individual and group curves on all three variables. In the past I have used some rather simple nonparametric statistics for looking at differences. It is quite clear that the major variable will be an intra-individual change from adaptation (days 1 and 2) to extinction (days 9 and 10). It has been suggested to me that there is some way of looking at clusters of all three variables at once as a measure of learning (Hoteling's T). However, I am not sure that with this small sample, non-normal data, etc., that that is feasible. Any suggestions?

It seems to me that at this early stage of experimenting, the automation of all these things should be kept simple--to leave room for changes in procedure and to maintain quite a bit of flexibility in the system. We are handicapped by the fact that our background knowledge of ongoing basal rates and individual differences in GSR nonspecifics, plethysmograph amplitudes, etc. is still quite limited.

Data Parameters:

1. Basal Resistance

In general, all subjects show an increase in basal resistance from day one to ten in this kind of study. The controls tend to show a

relatively greater increase than the experimental subjects.

There are side individual differences in basal resistance. In my 1964 study, I found that it varied from 61.9 K (MT, day 1) to 444.6 K (MH, day 5).

Within an individual, a maximum change of about 150-200 K could be seen from day one of the experiment to day ten. Median readings for each day were used as estimates of each subject's daily level.

Basal resistance can show rather marked change within a daily session for some individuals. In the 1964 study, at least one subject had an increase of over 200 K from beginning to end of the twenty minute session on day 9 (CJ). Other subjects tend to remain quite stable within a day's run and from day to day.

In general, subjects with low basal resistance put out a high frequency of nonspecifics, while subjects with high basal resistance produce few nonspecifics. For instance, in the 1964 study, one subject (MT) had an initial basal resistance of only 61 K and her output of nonspecifics was over 6 per minute. Another subject with a high basal resistance (331 K) had a nonspecific rate of .4 per minute.

2. Nonspecifics

In the 1964 study, experimentals tended to maintain their initial rate of nonspecifics while controls declined.

There are large individual differences in frequency of nonspecifics. In the 1964 study, the lowest reading on day 1 was .4 per minute, the high was over 6 per minute. Both experimentals and controls show some

decline in rate over the ten days, so the range on day 10 is .05 per minute to about 5 per minute.

I do not have any current data on amplitude of deflections. The smallest we counted was .4 K and the largest was 50 K, but there were unquestionably larger ones. Data from the 1962 study suggests that size tends to increase as basal resistance increases from day one to day ten; median amplitude increased as much as three times the day one amplitude (conductance readings).

3. Heart Rate

In the 1964 study, experimentals maintained their initial level of heart rate while controls showed a small but consistent decline.

Again, there are fairly large individual differences. In the 1964 study, the eighteen subjects ranged from 61.8 to 104.7 with a standard deviation of 12.8.

Under non-stressful repeated trials, the standard deviation within an individual is about 6 beats per minute. The maximum within individual variation that we saw over days was 15 beats per minute.

4. Plethysmograph

This data is purely ranked data. On the first day of the 1964 study we found that subjects varied from a minimum amplitude reading to twice that reading. Over the ten day session, controls tended to increase in amplitude while experimentals remain relatively constant. Some subjects doubled their amplitude over the ten days, while at least one subject showed a reading which was half as large as his initial amplitude.

Costs:

The heaviest expenses for this study will be tape and computer time. Each subject is run for 3 1/3 hours. We made some estimates at for this kind of study. I don't know whether these costs are comparable, but for what they're worth:

Apparatus batteries, etc.	$
Analog Recorder tape at	
Digital tape at	
Computer time. Analog to digital conversion at	
Computer time. Digital analysis at	
Subjects at	
Total	$

This does not include the cost of a computer programmer to set up the program. We estimated that might take as long as three months and cost about $